

Citrus Fruits of Assam: A New Key to Species, and Remarks on *Citrus assamensis* Bhattacharya and Dutta, 1956

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Abstract

The revision of *Citrus* in Assam by Bhattacharya and Dutta, 1956, is a work on citriculture and citrus taxonomy the importance of which is not limited to the Asean region; it contains a new species, *C. assamensis*, and a key to all the Assam citrus, as well as full descriptions of all taxa including the floral features. The utility of this work is enhanced by illustrations but constructional errors in the key have prevented its correct and effective use. A new key expressing the authors' intentions, as well as remarks on *Citrus* taxa and relationships and notes on the typification of *C. assamensis* are presented in this paper.

Introduction

S.C. Bhattacharya and S. Dutta published their important study of Assam *Citrus* "Classification of the *Citrus* Fruits of Assam" (1956) in Monograph 20 of the Indian Council of Agricultural Research. It is a major work in several important respects, as it includes not only full descriptions, including floral features, of all taxa, but it provides numerous vernacular names, a key to the species, and the diagnosis of a newly proposed species, *C. assamensis*. This contribution is thus valuable both to agriculture and to botany. It is also noteworthy for its adoption of several *Citrus* species which were suppressed (regarded as synonyms or hybrids) by Swingle in his classic revision of the Orange subfamily Aurantioideae (1943, 1967). While the authors generally follow Swingle's classification, they accept six species not recognized by Swingle among the 17 species recorded for Assam. These six species are *C. jambhiri*, *C. karna*, *C. limetta*, *C. nobilis*, *C. megaloxycarpa*, and their new *C. assamensis*.

Unusual for agricultural literature devoted to *Citrus*, Bhattacharya and Dutta include full technical data on the flowers of all taxa treated, omitting information only when their data was incomplete. Thus they provide fuller descriptions than is often the case, and the rather liberal use of illustrations also assists the botanist or agriculturist seeking information or identification. As experienced agriculturists their opinions are valuable, and their field knowledge, much gleaned in tribal villages with citriculture little influenced by modern commerce, presented in a generally judicious balance with botanical and "varietal" (cultivar) data, enhances the work.

Taxonomically Bhattacharya and Dutta are much closer in their taxonomic outlook to the conservative Swingle system than to the much more elaborate and finely divided system of Tanaka (1954). Reece (1967) in his editing of Swingle's

work hardly modified it, though Hodgson (1965) accepted several more species than did Swingle. In this respect, Bhattacharya and Dutta agree rather closely with Hodgson. The controversial taxa of *Citrus* are virtually all cultivated, and differences in classification therefore particularly involve citriculturists.

Key to Species

One of the worthy features of the Bhattacharya & Dutta study is, rightly, the inclusion of a key to the species. For practical purposes, such a key is always desirable, whether for agricultural or purely botanical purposes.

However the reader attempting to use this key soon encounters almost insuperable difficulties due partly to some peculiarities of its construction. In effect it is not so much a key as a collection of short, partial diagnoses. It is not possible at this date to understand why the key was prepared in this manner. Though in part dichotomous, the key later on becomes polychotomous. In effect the key is difficult to use at best and often enough is unworkable.

Because of this, it seemed beneficial to prepare a new key, based on the same data that Bhattacharya and Dutta used, which would be strictly dichotomous and effective. Without necessarily accepting all the taxa of *Citrus* that they recognize, any botanist or citriculturist will benefit from having a functional key permitting identification of the taxa as construed by these authors. Furthermore, a usable key may stimulate collecting and further investigations of *Citrus* both in Assam and perhaps elsewhere.

Correction of the Key.- An analysis of the key shows some functional couplets. The initial couplet divides the genus into the two groups recognized by Swingle as "Eucitrus" and "Papeda" (Bhattacharya & Dutta, 1956, p. 11, postscript). These two groups are subgenera in Swingle's classification. Within subg. Papeda the couplet N/NN separates *Citrus ichangensis* from *C. latipes*; subsequently however there is a solitary lead O, with a subordinate P, rather than couplets (P describes but does not fully discriminate *C. macroptera*). Within subg. Citrus ("Eucitrus"), *C. medica* is discriminated, but lead B is one of a trichotomy B/BB/BBB. Under BB, *C. limon* is discriminated, but leads D, E, G, and H are solitary, though there is a couplet F/FF. Lead E seems to indicate that the peel of both *C. limetta* and *C. megaloxycarpa* is loose, which is not true. In the last group under BBB the first "couplet is another trichotomy K/KK/KKK, each ending with a species; yet KKK is followed by 3 more leads, L, LL, and M (L and LL do not form a true couplet, as the half-couplet which should have been marked MM is annexed as the latter part of LL). Moreover *C. grandis* (from lead M) can be compared to *C. aurantifolia* (from LL), but lead L is inaccessible from the preceding KKK. Faults such as these prevent a user from successfully operating this key in a manner which is both baffling and misleading.

TABLE I

Species sequence in KEY	Species sequence in TEXT
<i>C. medica</i>	<i>C. medica</i>
<i>C. limon</i>	<i>C. limon</i>
<i>C. jambhiri</i>	<i>C. jambhiri</i>
<i>C. karna</i>	<i>C. karna</i>
<i>C. reticulata</i>	<i>C. aurantifolia</i>
<i>C. indica</i>	<i>C. limetta</i>
<i>C. limetta</i>	<i>C. reticulata</i>
<i>C. megaloxycarpa</i>	<i>C. nobilis</i>
<i>C. aurantium</i>	<i>C. indica</i>
<i>C. sinensis</i>	<i>C. sinensis</i>
<i>C. assamensis</i>	<i>C. aurantium</i>
<i>C. nobilis</i>	<i>C. grandis</i>
<i>C. aurantifolia</i>	<i>C. megaloxycarpa</i>
<i>C. grandis</i>	<i>C. ichangensis</i>
<i>C. latipes</i>	<i>C. macroptera</i>
<i>C. macroptera</i>	<i>C. assamensis</i>

Sequence of species in the classification.- The sequence of species in the key is not the same as that in the following systematic treatment. This is not necessarily very important, but it is of interest to compare the two sequences (Table 1).

The TEXT sequence is basically like the sequence in Swingle (1943, 1967), though it differs in two ways - first by the insertion of species not accepted by Swingle (these are in positions which at least implicitly indicate their taxonomic relationship); and second by the transposition of some species (e.g. in Swingle's arrangement, *C. aurantium* is no. 4, *C. sinensis* is no. 5, and *C. reticulata* is no. 6; in the Bhattacharya and Dutta sequence, *C. reticulata* with the immediately following *C. nobilis* - not in Swingle - precedes *C. aurantium* and *C. sinensis*, which are in reverse order. The pomelo, *C. maxima*, is in position no. 7 in both treatments, but in Bhattacharya & Dutta it is followed by *C. megaloxycarpa* (not in Swingle). Finally, the members of subg. Papeda come last. The last species in Bhattacharya & Dutta's sequence is *C. assamensis*, which is clearly asserted NOT to be a member of subg. Papeda; it ought to be inserted just after *C. megaloxycarpa*, its nearest (putative) relative. In fact in the key, *C. assamensis* is found between *C. sinensis* and *C. nobilis*, yet the authors take pains to show it is not closely related to *C. hystrix*, which is certainly a member of subg. Papeda. By

inference one may conclude that they thought that *C. assamensis* was related closely to either *C. sinensis* or *C. nobilis*, or both. In a short chapter on hybrid forms, the authors describe a cultivar called "hash-khuli" which, they suggest, may be a hybrid of *C. assamensis* and *C. maxima* (*C. grandis*). In my opinion, *C. assamensis* may be related to *C. megaloxycarpa* and to *C. maxima*, evidence being the similarity of leaf and petiole and in the former also the purplish corolla. In fact, Singh & Nath (1969) relegated *C. assamensis* to synonymy under *C. maxima*, or more precisely to one of the synonyms, *C. megaloxycarpa* var. *pennivesiculata*.

REVISED KEY TO CITRUS OF ASSAM

1. Pulp-vesicles lacking acrid oil droplets. Petiole unwinged, or marginate, or with a small to moderate wing never much more than 1/4 as long as the blade and less than 1/3 as wide. Stamens more or less connate or polyadelphous.

Subg. CITRUS

 2. Petiole unwinged, not articulated. Petals tinged purplish. Flowers dimorphic, staminate and perfect. Fruit large, usually elongated, yellow, the rind thick, hard, usually somewhat sweet or palatable. CITRON *Citrus medica* L.
 - 2' Petiole unwinged, moderately winged, or noticeably winged, and articulated.
 3. Petals noticeably purplish-tinged. Fruit greenish to yellow, ellipsoid to ovoid or elongated, often nipped at the end.
 4. Rind rather bumpy or warty, moderately to weakly adherent. Carpels rather easily separable. Petals 12-21 mm long. Stamens 21-28 per flower. Fruit up to 9.5 cm diameter. ROUGH LEMON *Citrus jambhiri* Lush.
 - 4' Rind relatively smooth, rather strongly adherent. Carpels strongly adherent. Petals 18-29 mm long. Stamens 19-49 per flower.
 5. Tree flowering all year round. Fruit rind rather thin, 3-10 mm thick, firm, not sweet, pulp and juice sour. Fruit subglobose to oblong, nipped, up to 9 cm diameter. Stamens 26-49 per flower. Petals 18-29 mm long. LEMON. *Citrus limon* (L.) Burm. f.
 - 5' Tree flowering but once a year, or only one major crop per year. Rind moderately thin, 5-7 mm thick, or thick to very thick, up to 35 mm. Stamens 19-42 per flower.
 6. Rind 10-35 mm thick. Fruit rather to quite large, often 12-14 cm diameter, sometimes smaller (7-12 cm diam.), not scented with ginger-like or eucalyptus-like odor.
 7. Fruit usually 7-12 cm diameter, rind soft and spongy, sweet, smooth or slightly pitted. Petiole wing 8-16 mm long, 2-3 mm wide. Stamens 24-29 per flower. KARNA *Citrus karna* Raf.
 - 7' Fruit usually 10-14 cm diameter, rind firm, leathery, or brittle, not sweet. Petiole wing usually 10-30 mm wide (rarely only 5-10 mm wide), about 1/7 to 1/4 as long as blade. Stamens 19-38 per flower. AMILBED. *Citrus megaloxycarpa* Lushington
 - 6' Rind 6-7 mm thick, leathery. Fruit 7-10 cm diameter, subglobose to almost turbinate. Rind oil with gingery or eucalyptus scent. Rind light yellow or pale greenish, almost smooth. Petiole wings somewhat broad, obovate, about 1/4 as long as wide as the blade. Stamens 26-42 per flower. ADA-JAMIR *Citrus assamensis* Bhattach. & Dutta
 - 3' Petals pure white. Fruit green, yellow, orange, or reddish, not lemon-like except in some forms of *C. auratifolia*.

8. Fruit with a loose, easily detached or separable rind. Cotyledons green. Leaves often rather narrowly elliptic or oblong-elliptic or somewhat rhombic.
 9. Seeds large orbicular flattened, 14-15 mm long, smooth. Fruit small, 2.5-4 cm diameter, oblate, the rind red, with scanty, slimy, very sour juice.
Filaments pubescent. Leaf apex somewhat caudate. Petiole scarcely winged.
INDIAN WILD ORANGE *Citrus indica* Tanaka
 - 9' Seeds small, medium, or large (to 16 mm long), somewhat cuneate, slightly rough, or somewhat clavate with fin-like projection of testa. Fruit orange to red, often oblate, sour to quite sweet, juice not slimy, rather copious and palatable. Filaments glabrous. Leaf apex not caudate. Petiole wing small and narrow (or nil) or broad and obovate-oblongate.
 10. Petiole wing conspicuous, broadly spatulate, up to nearly half as long as the blade, but only one-fourth as wide. Stamens mostly 22-32 per flower. Rind 5-9 mm thick.
KING ORANGE *Citrus nobilis* Lour.
 - 10' Petiole wing small, very narrow, or nil. Stamens 14-24 per flower. Rind about 5 mm thick. MANDARIN *Citrus reticulata* Blanco
- 8' Fruit with tightly adherent rind. Seeds with white cotyledons. Leaves various in shape, but not rhombic.
 11. Petiole short and virtually wingless. Rind light yellow, glossy. Fruit subglobose, lemon-like. Pulp vesicles whitish. Juice sweet. Chalazal cap ochre-yellow. SWEET LIME
..... *Citrus limetta* (Risso) Lush.
 - 11' Petiole winged, wings narrow to broad.
 12. Petiole wing small, narrow, up to 12-15 mm long and 5-10 mm wide.
 13. Fruit 4-5 cm diameter, subglobose to oblong. Rind very thin. Pulp vesicles greenish to whitish. Juice sour. Chalazal cap brown. LIME
..... *Citrus aurantifolia* (Christm.) Swingle
 - 13' Fruit 5-9 cm diameter, subglobose. Rind 4-7 mm thick, yellow to orange. Pulp vesicles yellowish to orange. Juice usually sweet. Chalazal cap "Indian red."
Petiole wing 10-20 mm long, 1-3 mm wide. SWEET ORANGE
..... *Citrus sinensis* L.
 - 12' Petiole wing larger, broader, up to 7 cm long and 5 cm wide.
 14. Inflorescence glabrous, few-flowered. Stamens 22-24 per flower. Fruit 6.5-8.5 cm diameter, deep orange to scarlet. Rind 7-10 mm thick. Pulp vesicles yellow to orange. Juice very sour and somewhat bitter. Seeds 12-16 mm long. Chalazal cap "Indian red." SOUR, BITTER, or SEVILLE ORANGE
..... *Citrus aurantium* L.
 - 14' Inflorescence racemose-glomerate, pubescent, with up to about 10 flowers. Stamens mostly 30-40 (rarely as few as 22) per flower. Fruit often 10-15 cm diameter, green to yellow, sometimes tinged pinkish, the rind often 10-20 mm thick or more. Juice rather bland, or mildly tart or sweet. Seeds 15-23 mm long. Chalazal cap brown or reddish-brown. POMELO
..... *Citrus maxima* (L.) Merr.
- 1' Pulp vesicles containing acrid oil droplets. Petiole long, broadly winged, the wing almost as wide or as wide as the blade, and from half as long to longer than the blade. Stamens usually free, rarely coherent.
Subgenus PAPEDA
15. Leaf apex acuminate-caudate. Stamens coherent. Pulp vesicles globose to obovoid, white. Juice sour and scanty. Seeds numerous, 12-20 mm long, 10-28 mm wide. Chalazal cap broad, brown.
..... *Citrus ichangensis* Swingle
- 15' Leaf apex not caudate. Stamens free. Seeds somewhat smaller. Chalazal cap light red.

16. Leaf apex acute to subcaudate. Fruit about 5-10 cm diameter. Style 4-8 mm long. *Citrus latipes* Swingle
- 16' Leaf apex rounded to obtuse. Fruit usually over 10 cm diameter. Style 1-4 mm long. MELANESIAN PAPEDA. *Citrus macroptera* Montrouzier

Vernacular Names

Bhattacharya and Dutta provide a wealth of vernacular names applied to various forms and cultivars of the *Citrus* species in Assam. For completeness these are repeated here; those capitalized are the "preferred" names.

Citrus medica. (CITRON). Birajora; mithajora; soh-manong; bakol-khowatenga; soh-madeh; jaara-jamir; tumehan-thor; haijange; naya-changney; bhimra; mokari; mohalung; sutrung; madh-kunkur; madh-kakri; maulung; natterun.

Citrus jambhiri (ROUGH LEMON). Soh-myndong; soh-jalia; kata-jamir; sinduri-nemutenga; mithu-tulia; nemu-tenga.

Citrus limon (LEMON). Naya-changney; pati-lebu; katajamuri; elachi-lebu; soh-long; soh-synteng; pani-jamir.

Citrus karna (KARNA). Karna; soh-sarkar.

Citrus megaloxycarpa (AMILBED). Amilbed; bor-tenga; hukma-tenga; holong-tenga; jama-tenga.

Citrus assamensis (ADA-JAMIR). Ada-jamir.

Citrus indica (INDIAN WILD ORANGE). (No vernacular names recorded).

Citrus nobilis (KING ORANGE). Jeneru-tenga.

Citrus reticulata (MANDARIN). Sweet forms: soh-niamtra; soh-umkdai; naga-santra. Sour forms: soh-siem; kapura-tenga.

Citrus limetta (SWEET LIME). Mitha-kagzhi; mou-muri; soh-bakhlein.

Citrus aurantifolia (LIME). Kagzhi.

Citrus sinensis (SWEET ORANGE). Soh-niangriang.

Citrus aurantium (SOUR ORANGE). Karun-jamir; gondh-kuntra.

Citrus maxima (POMELO). Rebab-tenga; soh-myngor; mat.

Citrus ichangensis. (No vernacular names recorded).

Citrus latipes. Soh-kympho-shrieh.

Citrus macroptera (MELANESIAN PAPEDA). Sat-kara; tith-kara.

Note On Typification of *Citrus assamensis*

In the protologue, Bhattacharya and Dutta do not specifically mention a "type" but they remark (1956, p. 787) "The original specimen had . . . been sent to Kew Herbarium . . ." and it may be assumed that by this they indicated the type. I have examined the relevant material at Kew and choose the fuller sheet as the lectotype. The label of this specimen reads as follows: "Herbarium, Citrus Fruit Research Station, Burnihat, Assam. - Fam. Rutaceae. *Citrus assamensis* Dutta & Bhattacharya, sp. nov. Vernac. name, ada-jamir. - Plant medium-sized, very thorny, stout; leaves coriaceous, glossy; petiole spatulate, margin revolute; flower purple; fruit spherical smooth; aroma eucalyptus smell; pulp free from oil droplets." The locality data is: ASSAM, Karimganj, alt. about 300 ft., 6 November 1938, S. Dutta & S.C. Bhattacharya no. 2365. K! (lectotype).

Because of the significance of this species, and to provide an example of the thoroughness of the descriptions employed by Bhattacharya and Dutta, the original description is suggested as a model of its kind. From the original publication, the authors note is here quoted. "The specimen of ada-jamir as it is known locally has been collected from an interior village in Karimganj subdivision of the district of Cachar, Assam . . . identical specimens have also been found to occur particularly in Sylhet, North Cachar hills, and Khasi hills. It is sporadically grown in home gardens." (Note that Sylhet now is within Bangladesh).

Bhattacharya & Dutta showed that *C. assamensis* could not be assigned to *C. hystrix* (a table of differences is presented) but nevertheless referred to subgenus Papeda which includes *C. hystrix*. However, the absence of acrid oil droplets in the pulp-vesicles must exclude *C. assamensis* from subg. Papeda.

More probably *C. assamensis* is closely related to the Pomelo, *C. maxima* (*C. grandis*, *C. decumana*), and to the Amilbed or Sour Pomelo, *C. megaloxycarpa* - with which the Ada-jamir shares its purplish petals and sour juice. The placement of *C. assamensis* in the original key (of Bhattacharya & Dutta) between *C. sinensis* and *C. nobilis* apparently does not indicate relationship.

The "ginger or eucalyptus odor" specified for *C. assamensis* is noted as very characteristic; "the fruits are valued locally for their peculiar aromatic flavour and intense sour juice. The aroma of the rind approaches to eucalyptus smell but people characterize it to be similar to that of the ginger, *Zingiber officinale*, and hence the name "ada-jamir" (ada = ginger; jamir = citrus). It is also called Soh-sying (soh = soft; sying = ginger) in the Khasi hills of Assam."

Postscript

This paper clarifies the key structure in the work by Bhattacharya & Dutta; clarifies the typification and posited relationship of their new species *Citrus*

assamensis; and commends their descriptive work to botanists and agriculturists as a suitable model. The status of *C. assamensis* remains controversial; renewed study of it is recommended. Good specimens of *C. indica*, *C. assamensis*, *C. ichangensis*, *C. latipes*, and *C. jambhiri* are worth obtaining in the Assam area.

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